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ABSTRACT

In order to provide detailed descriptions of instructors' activities in courses taught by individualized instruction and to identify some of the factors responsible for variations in those activities, records were made of instructor behavior in two computer-managed Navy courses. Within each course, jobs differed considerably in kinds and patterns of activities and total demands on the instructor. Most of the specialized jobs in one course had nominal parallels in the other, but the activities observed in these parallel jobs were quite different. Most instructors spent the major part of their time in brief, relatively routine interactions; complex tutorial interactions were rare. Findings suggest that differences in course design affect demands on the instructor and that systematic tradeoffs have not always been made between such demands and training effectiveness. It is recommended that a single set of student-instructor ratios not be used to compute instructor authorizations for all such courses and that instructor training courses avoid creating unrealistic expectations of actual job performance. Since instructor roles vary so widely, considerable caution should be exercised in selecting a common core curriculum for such courses. (Author/LMM)

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INSTRUCTOR'S ROLE IN INDIVIDUALIZED TRAINING: A SURVEY OF TWO COMPUTER-MANAGED COURSES

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Detailed records were made of instructor behavior in two Navy courses taught by means of individualized instruction. There were five specialized jobs in one course and six in the other. The jobs within each course differed considerably from one another in (1) the kinds and patterns of activities and (2) the total demands on the instructor. Most of the specialized jobs found in one course had nominal parallels in the other course, but the activities observed in these parallel jobs were frequently quite different. Most instructors

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spent the major part of their time in brief, relatively routine interactions; complex tutorial interactions were rare.

FOREWORD

This research and development was conducted in support of FY79 exploratory development task area ZF55.522.002 (Methodology for Development and Evaluation of Navy Training Programs), under the sponsorship of the Chief of Naval Technical Training. The purpose of the R&D was to provide detailed descriptions of instructor activities in courses taught by individualized instruction and to identify some of the factors responsible for variations in those activities. This information should help those responsible for designing individualized instruction courses, managing the courses, calculating instructor requirements, and training instructors.

Appreciation is expressed to the personnel of the Basic Electricity and Electronics School and the Aviation Fundamentals School, Naval Air Technical Training Center, Memphis, for their cooperation and assistance.

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SUMMARY

Problem

Individualized instruction is creating major changes in the role of Navy instructors, but there is little quantitative information on these revised roles. Such information is needed as a basis for improving the design of individualized training systems and for managing their operation.

Purpose

The purpose of this research was to provide detailed, quantitative descriptions of the activities of instructors in a sample of two Navy courses taught by individualized, computer-managed instruction. An effort was made to identify specific factors in the subject matter or the course design that contribute to demands on the instructors.

Method

Detailed records were kept of the activities of instructors working in the specialized jobs found in the Basic Electricity and Electronics (BE/E) and the Aviation Fundamental (AFUN) courses. The records indicated the kind of activity observed, the factors that initiated the activity, and the time devoted to each episode of the activity.

Results

Both courses had regular learning center instructors (LCIs), learning center supervisors, testing supervisors, and shop supervisors. AFUN had terminal operators and BE/E had two kinds of quiet-study supervisors. Instructors were normally assigned to a single job, although some were rotated through two or even three specialized jobs. The division of labor among jobs created large differences in the demands on different instructors and in the patterns of their activities. In BE/E, for example, the LCIs had less than nine contacts with individual students per hour, whereas the quiet-study terminal operators had over 74.

The activities of instructors in nominally parallel jobs in the two courses were often as different as those of instructors in different jobs within the same course. Most instructors devoted most of their time to brief, relatively routine interactions with individual students. There were few complex tutorial interactions.

Conclusions

1. The BE/E and AFUN courses differed in the assignment of functions to instructors.

2. The demands placed on instructors varied widely between different jobs in a course and nominally parallel jobs in different courses.

3. Differences in course design (e.g., the sizes of modules, the standards for mastery, and the criteria for instructor intervention) affected demands on the instructor.

4. Differences in course design indicate that systematic tradeoffs have not always been made between training effectiveness and demands on the instructor. However, the information needed for relating various design elements to training effectiveness is not available.

5. Instructors must spend most of their time on relatively routine transactions. Under such circumstances, it may be counterproductive for instructor training courses to stress the glamorous aspects of the job. If might be better to provide a realistic picture of responsibilities to reduce dissatisfaction later on.

Recommendations

1. A single set of student-instructor ratios should not be used to compute instructor authorizations for all courses taught by individualized instruction.

2. Instructor training courses should avoid creating unrealistic expectations about what instructors in individualized courses will actually do on the job. Since instructor roles vary so widely, considerable caution should be exercised in selecting a common core curriculum for such courses.

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INTRODUCTION

Problem

Individualized, self-paced training is now the primary means of instruction in many Navy classrooms. The introduction of individualized instruction required major changes in the traditional role of the Navy instructor. Although considerable literature has been devoted to these new roles, little research has addressed the actual duties performed. In the absence of empirical data or specific directives, the individual Navy schools have had to work out problems of using instructors most effectively within available resources.

Purpose

The purpose of this research was to provide detailed descriptions of instructor activities in two Navy courses taught by means of individualized, computer-managed instruction (CMI). These descriptions are not models for standardizing the roles, since the activities that instructors are performing now may be quite different from the activities they might be performing in an optimal instructional system. However, data on actual activities may serve to highlight certain demands and constraints that have been overlooked or underestimated in previous discussions of the instructor's role.

Scope

This report describes a number of fairly discrete studies on different instructor roles. The Method section provides a general description of the two courses observed and of procedures common to all observations. The Results section provides descriptions of the specific procedures and results for each of the roles observed.

METHOD

Courses

Data were collected on the activities of instructors in the Basic Electricity and Electronics (BE/E) and Aviation Fundamental (AFUN) courses at the Naval Air Technical Training Center, Memphis, in 1976-1977. In each course, the instructional material was organized into a hierarchy of units. Objectives related to a single topic were organized into a lesson; several lessons, usually covering related topics, into a module; and several consecutive modules, into a phase. A course comprised two or more phases.

Method of Instruction

Both courses were taught by means of self-administered instructional materials, were individually paced, and were supported by CMI. The typical instructional sequence began with a computer-printed lesson guide that assigned the student to the lessons in a module, a module test, and, occasionally, a laboratory exercise. Each lesson concluded with a self-test. The student took the module test whenever he felt qualified to do so. When a student failed to reach an acceptable level of mastery on any lesson within a module, the computer listed the lessons requiring remedial study and assigned a test for each. A student failing a prescribed number of tests on a given lesson was referred to the instructor for individual attention. When a student mastered each lesson of a module, the computer printed a lesson guide assigning a new module, or, if all modules in a phase had been completed, a phase test.

The computer also provided a daily learning center roster that indicated where each student was in the course, how long the student had been on a current assignment, how long it should take to complete the course, and how well the student was performing relative to other students of comparable ability.

Course Content

The BE/E course provides an introduction to electronic theory that is a common requirement for several Class "A" courses. (A curriculum outline of this course is provided in Appendix A.) The course consists of 80 lessons (11 on mathematics and 69 on electronics), 13 laboratory exercises, and 6 performance tests. Most students take all 69 electronics lessons, which require approximately 155 hours. A small percentage of the students (those who have been selected for a particular follow-on course) graduate after completing the first 54 electronics lessons. The average lesson required approximately 2 hours, and module or mathematics tests occurred every 6 to 8 hours, depending on the number of tests assigned. The course was taught in two shifts, the first from 0600 to 1200; and the second, from 1230 to 1830. There were no meal breaks.

The AFUN course, comprising 39 lessons, provides instruction on common requirements for technical jobs in Navy and Marine Corps aviation--aircraft systems, aircraft handling, maintenance documentation, and use of hand tools. (Appendix B contains the curriculum outline.) Students take only the lessons required by their ratings, the number ranging from 11 to 38. The average lesson took about 1.3 hours and the average interval between module tests was about 2.8 hours. The course was taught in a single shift, from 0730 to 1600, with 1 hour off for lunch.

Facilities

The facilities for each course included administrative offices, several learning centers, a quiet-study area (for work done outside the student's normal hours), a laboratory or workshop area, and a special room for phase tests. The BE/E course had four learning centers, each containing between 120 and 180 individual study carrels, a classroom terminal consisting of an optical scanning device for reading answer sheets and a small printer for producing learning guides, and several special carrels that were used for module tests, audiovisual programs, or laboratory projects. The AFUN course had seven learning centers, but only five were in operation during this study. Each AFUN learning center contained between 70 to 127 individual study carrels and a classroom terminal.

Instructor Roles Studied

People in instructor billets are used in a wide variety of jobs. The roles selected for analysis in this study were limited to those needed to "replace" the conventional classroom instructor. These roles are listed below:

1. Learning center instructor (LCI) (BE/E and AFUN)
2. Classroom terminal operator (AFUN)
3. Learning center supervisor (BE/E and AFUN)
4. Testing supervisor (BE/E and AFUN)
5. Shop supervisor (BE/E and AFUN)
6. Quiet-study supervisor, terminal and regular (BE/E)

Procedure

Data were collected by an observer who sat or stood near the instructor and recorded his activities. To minimize the impact of the observations on the activities being observed, the instructors were briefed on the purpose of the project and were assured that the data collected would not be associated with an individual instructor. Students were informed that the instructor activities were being observed but that the exercise was not an evaluation of either the instructor or the students. Students were encouraged to behave as they would in the absence of an observer.

Before observations of a new type of job began, documents pertaining to that job were reviewed and an incumbent was observed informally. Activities that might be difficult to classify from observation alone were identified, and procedures were developed to resolve the ambiguities as unobtrusively as possible.

The observer used a digital clock to record the minute during which each activity started and stopped. More precise recordings were attempted during a pilot study but were found to be difficult and subject to error. The minute-by-minute recordings provided averages that were accurate, even for relatively brief transactions.

There are a variety of dimensions along which instructor behavior might be classified. The categories used in this study were selected because they were meaningful, easy to use, objective, mutually exclusive, and applicable to a variety of jobs. They were reviewed and discussed with samples of instructors prior to the observation phase of this research.

RESULTS

In this section, data on times and frequencies are all averages, calculated over a number of observations on a number of instructors.

Learning Center Instructor (LCI)

BE/E

The BE/E LCI was assigned specific responsibility for students in a block of approximately 20 carrels. Students with problems normally came to his desk, although he occasionally circulated through his assigned area. If the instructor was away from his desk or had a number of students waiting in line to see him, students might go to a neighboring instructor who was free.

For purposes of observation, each of the two BE/E shifts was divided into three 2-hour periods. Within each shift, periods were strictly balanced against days of the week. This provided 15 observations for each shift, or a total of 30. Observations in the four learning centers were roughly balanced over both periods and days of the week.

Table 1 indicates the number of minutes spent by LCIs in each of eight activities. For activities that entail one-to-one contacts or interactions with students, it also indicates the number of interactions per hour and the number of minutes per interaction. The instructors spent a little less than 42 minutes an hour, or 70 percent of their time, in direct one-to-one interactions with students. There were 34 separate interactions per hour. Since there was an average of 17.1 students per instructor, this represents two interactions per student per hour. Students had to stand in line for roughly half their interactions, spending approximately 1.6 minutes per hour in line, or two-thirds as much time as they spent in actual interactions with the instructor.

Table 1

BE/E LCIs: Distribution of Activities

Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contact
1. Computer-initiated contacts	6.2	4.5	1.4
2. School requirements	15.6	15.6	1.0
3. Manual evaluation of tests	2.1	1.5	1.4
4. Technical questions	13.3	8.0	1.7
5. Nontechnical questions	3.0	3.4	0.9
6. Instructor-initiated contacts	1.5	1.0	1.4
7. Administrative activities	8.0	--	--
8. Nonproductive activities	10.4	--	--
Total	60.1	34.0	

1. Computer-initiated Contacts. Whenever the student missed a question, the computer directed him to the instructor. The instructor spent 6.2 minutes per hour on these interactions. The instructor generally recorded the student's progress and took whatever actions were required for the student to continue work (e.g., cleared the student from the test or told him to continue with his assignment). For two-thirds of these interactions, this was all that was done. These interactions lasted an average of .9 minute each. When the instructor made an explicit attempt to diagnose and correct student difficulties, the interactions lasted about 2.3 minutes each. Most of this time involved pure mechanics--retrieving the microfiche card that contained the test, mounting it in the viewer, locating the test, and reading the individual questions--leaving little time for the analysis and correction of the actual difficulty. One purpose of these contacts was to provide the instructor with an opportunity to select remediation. In most cases, however, the instructor's selections were quite predictable and could probably have been handled by the computer.

2. School Requirements. The instructor spent 15.6 minutes per hour checking student work and procedures. These interactions were generally initiated by instructions embedded in the training materials or by standard instructions established at the beginning of the course. Roughly half these interactions were purely procedural, had little direct instructional impact (e.g., checking an answer sheet for proper format or granting permission to take a test without checking any of the student's work), and required only .6 minute each. Roughly 19 percent of the interactions were devoted to grading practice problems that had been assigned and, in many cases, prepared by the instructor (1.6 minutes each); and almost 30 percent, to checking laboratory exercises, workbooks, or self-tests (1.3 minutes each).

3. Manual Evaluation of Tests. The instructor spent 2.1 minutes per hour on the manual grading of answer sheets. This was done when (a) the computer was down, (b) the student had not yet been entered in the course, (c) the student had exhausted all available assignments, or (d) the instructor wished to preclude the second failure of a lesson test.

4. Technical Questions. The instructor spent 13.3 minutes per hour answering technical questions on course content. The average time per interaction was 1.7 minutes. Some questions could be answered with a single word, while others required as much as 10 minutes.

5. Nontechnical Questions. The instructor spent 3 minutes per hour answering questions unrelated to course content. Most questions concerned proper procedures or the location of materials and equipment; a few dealt with personal or extracurricular problems. The average interaction lasted .9 minute.

6. Instructor-initiated Contacts. The instructor spent 1.5 minutes per hour in interactions that he initiated with individual students. About half of these were related to violations of proper procedures (1 minute each); most of the rest were related to the rate of student progress (1.9 minutes each).

7. Administrative Activities. Approximately 8 minutes per hour were spent on administrative activities. These included reviewing learning center rosters, preparing paperwork for academic review boards, preparing practice problems, lecturing the group on disciplinary matters or lack of application, maintaining equipment and materials, participating in job-related interactions with other instructors, and general monitoring of learning center activities. Most administrative activities were sandwiched into intervals between other activities and were interrupted when a student needed help. Less than a minute per hour was spent at the computer terminal.

8. Nonproductive Activities. About 10 minutes per hour were spent in noninstructional activities. Most of this time was spent in brief pauses between activities; less than half was spent in formal breaks or social interactions.

The data were examined for differences due to shift, day of week, and time within shift. Summaries of the variations along each of these dimensions are provided in Appendix B. There was little difference between the morning and afternoon shifts, so this dimension was used as a random variable to test the reliability of differences along the other two dimensions. Periods within shifts were tested in 2-hour blocks to avoid the complication of repeated observations of the same instructors. Only administrative activities varied reliably across periods. This was because most instructors reviewed learning center rosters during the early part of the shift. In most learning centers, students were not allowed to start work on a test during the last 30 minutes of the shift, and the terminal was closed 10 to 15 minutes before the shift ended. These constraints tended to depress both computer-initiated contacts and school requirements, but the effect was not large enough to create reliable differences among the 2-hour blocks. Nevertheless, the time spent in these two activities decreased by 8.6 minutes ($p < .05$) between the fifth and sixth hours of the shift. The instructors tended to spend more time interacting with the students during the middle of the shifts than during either the beginning or end ($p < .05$). The activities were fairly stable across days of the week. An interaction ($p < .05$) occurred between days and periods for nontechnical questions, but no obvious explanation was found for the pattern.

AFUN

The AFUN LCIs, unlike those in BE/E, tended to circulate through the center and assume general responsibility for any student needing help. Most interactions took place at the student's carrel. This situation created a problem for the observer, since there was no way to compensate for an instructor who assumed more or less than his share of responsibilities. A second problem was created by the unusually small number of students

in the school. To resolve these problems, each instructor being observed was assigned responsibility for approximately 20 students--a number approximating his share if the school had been operating at near capacity.

For purposes of observation, the AFUN training day was divided into 4 periods--3 periods of 2 hours each and a final period of 1.5 hours. Each instructor was observed for a single period. Periods were strictly balanced over days of the week, for a total of 20 observations. Learning centers were roughly balanced over both periods and days.

Table 2 shows that instructors spent almost 27 minutes per hour, or 45 percent of their time, in one-to-one interactions with students. There were about 18 separate interactions per hour. Since there were about 18.7 students per instructor, this represented one interaction per student per hour (about half the number found in BE/E). The students rarely had to wait for the instructor.

Table 2

AFUN LCIs: Distribution of Activities

Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contact
1. Computer-initiated contacts	9.3	2.5	3.7
2. Technical questions	9.2	4.8	1.9
3. Nontechnical questions	4.8	6.3	0.8
4. Instructor-initiated contacts	3.7	4.0	0.9
5. Administrative activities	9.9	--	--
6. Nonproductive activities	23.2	--	--
Total	60.1	17.6	

1. Computer-initiated Contacts. The instructor spent 9.3 minutes per hour on interactions initiated by computer printouts. In this course, the student was sent to the instructor whenever he failed to reach 90 percent on either a phase test or a lesson test. Remediation to 100 percent was not required, as it was in BE/E, and all failures on the module tests were handled by the computer without instructor intervention. Most of the time was spent on lesson tests, and took the form of a detailed discussion of each item missed. These interactions were fairly infrequent (2.5 per hour, or about half the number in BE/E) but time-consuming (3.7 minutes each, or over 2-1/2 times as long as those in BE/E).

2. Technical Questions. The instructor spent 9.2 minutes per hour answering technical questions about the course content. This was less than the time spent in BE/E (13.3 minutes). However, the time per question (1.9 minutes) was actually somewhat longer than in BE/E (1.7 minutes), even though the subject matter was less complex.

3. Nontechnical Questions. Almost 5 minutes per hour were spent in answering nontechnical questions. These contacts were relatively brief (.8 minute each). The frequency was higher than in BE/E, probably because AFUN students were new to both the training center and CMI.

4. Instructor-initiated Contacts. The instructor spent 3.7 minutes per hour in contacts he initiated. However, 2.8 minutes of this time were devoted to interactions that did not appear to be prompted by any particular problem or student behavior. Some of these interactions may have been attempts to demonstrate an interest in the student; others may simply have been attempts to appear busy.

5. Administrative Activities. Almost 10 minutes were spent in administrative activities. Although this was somewhat more than was spent in the BE/E course, a major part (7.7 minutes) was spent in simply walking around the learning center and monitoring the students. It is likely that the AFUN instructor, who normally was not tied down to any particular part of the learning center, simply moved about while waiting for something else to do. To the extent that this is true, the monitoring might better have been classified as nonproductive activity. The remaining activities in this category accounted for considerably less time than in BE/E (2.2 vs. 8 minutes). A major part of the difference was probably due to the fact that these instructors did not have specific responsibility for individual students. As a result, they spent less time on activities such as reviewing the learning center roster, preparing paperwork for academic review boards, or lecturing to the students as a group, activities that tended to be assumed by the learning center supervisor.

6. Nonproductive Activities. The instructor spent 23.2 minutes per hour in clearly nonproductive activities. If this time were added to the time devoted to spontaneous instructor-initiated contacts and monitoring, both of which could probably be reduced or eliminated without loss, it would account for over half the instructor's time.

Two activities recorded for the BE/E LCIs--manual evaluation of tests and school requirements--were not recorded for the AFUN LCIs. The reasons why these were not significant activities in AFUN are given in the discussion section. One duty normally performed by the AFUN instructor was also excluded. When new students arrive at the learning center, they are generally given an orientation lecture by one of the instructors. Although this lecture, lasting up to 30 minutes, was delegated to instructors other than those being observed, its overall impact on instructor time can be calculated. If it is assumed that there are five nonspecialized LCIs per center, the briefings would require an average of only 1.6 minutes per LCI per hour.

The data were examined for differences due to day of week and hour of day, even though there was no convenient way to test the reliability of these differences. Summaries of variations are included in Appendix B. The activities tended to be somewhat more variable over both days and hours than they were in the BE/E course, probably because of the smaller number of observations per activity. In neither case were there obvious trends.

Classroom Terminal Operator

BE/E

There was no specialized role of this kind in BE/E. Students fed their own answer sheets into the scanner and removed the resulting evaluation from the printer. The regular LCIs did whatever else was needed at the terminal.

AFUN

In each learning center, there was one instructor, located at a desk within easy reach of the classroom terminal, whose primary duty was to operate the terminal. The number

of students served by the terminal varied with the size of the learning center and the onboard load. At the time of these observations, there were about 70 students assigned to each terminal. In most centers, the role of operator was rotated among the LCIs on a daily basis.

The AFUN operators were not observed extensively because there were few of them and their activities tended to be relatively mechanical and predictable. Five different operators from five different learning centers were observed for 1.5 hours each. The observations were distributed over periods of the training day and days of the week.

The AFUN classroom terminal operator performed many of the same duties as the LCI, but the time devoted to these duties was far less. To simplify the reporting, these activities have been grouped into a single category--instructional activities. These and other activities are summarized in Table 3.

Table 3

AFUN Terminal Operators: Distribution of Activities

Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contact
1. Instructional activities	6.2	10.4	0.6
2. Test evaluation	26.5	45.8	0.6
3. Computer operations	5.7	--	--
4. Nonproductive activities	21.6	--	--
Total	60.0	56.2	

1. Instructional Activities. The instructor spent slightly over 6 minutes per hour in instructional activities of the kind common to LCIs, primarily answering nontechnical questions. These contacts averaged only .6 minute because the operators tended to refer more complicated questions or problems to the regular instructors.

2. Test Evaluation. These activities accounted for 26.5 minutes per hour, or almost 70 percent of the operator's productive time. When the student brought an answer sheet to the terminal for evaluation, the instructor checked the format, inserted the sheet into the optical scanner, read the printed evaluation, and discussed the evaluation with the student. These contacts took only about .6 minute each. Since much of this time was required by the terminal to scan the answer sheet and print the evaluation, the discussions were obviously quite brief.

3. Computer Operations. Almost 6 minutes per hour were devoted to more direct forms of interaction with the computer. This included deleting assignments, assigning additional tests, opening or closing the terminal, and making corrections for time lost because of absences. These activities took only .8 minute each.

4. Nonproductive Activities. The operators spent 21.6 minutes per hour in nonproductive activities. This is a considerable amount of time, but the learning centers were operating at about two-thirds of their maximum capacity. If the time spent in

productive activities is divided by two-thirds (to approximate maximum demand), it would account for most of the hour.

Learning Center Supervisor

BE/E

At the time of these observations, the average learning center had 85 students distributed among five LCIs. The supervisor had overall responsibility for the center and, in particular, for monitoring the activities of the LCIs, handling a variety of administrative matters within the center, and providing the primary administrative link between the center and the remainder of the school. In addition, the supervisor sometimes shared the duties of the LCIs during periods of peak activity. This generally occurred when a student found him free, so students spent less than 1.5 minutes per hour waiting to see him.

There were eight BE/E learning center supervisors, four on the morning shift and four on the afternoon shift. Each supervisor was observed on 2 different days, once during the first 3 hours of his shift and once during the last 3 hours of his shift.

Although most of the supervisor's activities could be classified into the same categories used for LCIs, it was felt that a regrouping of some activities would simplify the description. Table 4 summarizes these and other activities.

Table 4

BE/E Learning Center Supervisors:
Distribution of Activities

Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contact
1. Instructional activities	7.2	3.5	2.0
2. Orientation	3.7	0.5	6.9
3. Nontechnical questions	3.2	3.2	1.0
4. Instructor-initiated contacts	3.8	1.4	2.7
5. LCI contacts	9.9	4.7	2.1
6. Administrative activities	19.4	--	--
7. Nonproductive activities	12.8	--	--
Total	60.0	13.3	

1. Instructional Activities. The supervisor spent 7.2 minutes per hour on computer-initiated contacts, school requirements, manual evaluation of tests, and technical questions. This is less than a fifth of the time spent by LCIs in similar activities. Each interaction averaged slightly over 2 minutes--longer than similar interactions for LCIs. This was partly due to the fact that a disproportionate number of these interactions were with new students.

2. Orientation. The supervisor spent 3.7 minutes per hour in orienting groups of new students. This generally took the form of one fairly long presentation each shift, sometimes followed by several shorter presentations.

3. Nontechnical Questions. About 3.2 minutes per hour were spent on nontechnical questions, primarily procedural questions by new students.

4. Instructor-initiated Contacts. The supervisor spent 3.8 minutes per hour on interactions he initiated. This was more time than was spent by the LCIs on similar contacts because more time was needed to counsel students who were being prepared for senior academic review boards.

5. LCI Contacts. Job-related interactions with LCIs accounted for almost 10 minutes per hour of the supervisor's time. Most of these interactions were relatively brief, but there was one extended counseling session with an instructor who was having difficulties.

6. Administrative Activities. Almost a third of the supervisor's time was devoted to administrative activities. Most of this time was spent preparing and reviewing the paperwork associated with academic review boards and reviewing learning center rosters.

7. Nonproductive Activities. Supervisors spent 13 minutes per hour on nonproductive activities. At least part of this time was spent on quasi-official social contacts with both subordinates and supervisors. These may actually represent an important element of the job.

The only noteworthy variation disclosed by analyses of shifts, days, and hours was a concentration of administrative activities during the first hour of the shift. This was due to work on the learning center roster, just as it was in the case of LCIs.

AFUN

At the time of these observations, the average AFUN learning center had about 70 students and from 6 to 10 LCIs. Under normal circumstances, it would have had about 100 students and 6 LCIs (extra instructors were available because two learning centers had been temporarily closed). The primary duties of the AFUN supervisors were roughly the same as those of the BE/E supervisors.

There were only five AFUN learning center supervisors at the time of this research. Each supervisor was observed for a period of 1.5 hours, with the periods arranged to cover the entire training day and the 5 days of the week.

AFUN supervisors spent more time than did BE/E supervisors on interactions they did not initiate (16.1 minutes per hour). Even so, students spent a negligible amount of time waiting in line. Supervisor activities are summarized in Table 5.

1. Computer-initiated Contacts. About 9.5 minutes per hour were spent on computer-initiated interactions. This time was spent providing remediation following the failure of either a lesson test or a phase test. Contacts were fairly infrequent (2.4 per hour) and fairly long (4 minutes each).

2. Technical Questions. The supervisors spent 2.3 minutes per hour on technical questions, but this may not be a reliable figure. Such questions were quite rare (.5 per

Table 5

AFUN Learning Center Supervisors:
Distribution of Activities

Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contact
1. Computer-initiated contacts	9.5	2.4	4.0
2. Technical questions	2.3	0.5	4.5
3. Nontechnical questions	4.3	6.1	0.7
4. Instructor-initiated contacts	0.9	1.6	0.6
5. LCI contacts	6.0	5.2	1.1
6. Administrative activities	19.8	--	--
7. Nonproductive activities	17.3	--	--
Total	60.1	15.8	

hour), and most of the time was accounted for by one supervisor who spent 13 minutes on a single question.

3. Nontechnical Questions. The supervisors spent 4.3 per hour on nontechnical questions. Far fewer senior academic review boards were conducted in the AFUN course than in the BE/E course, accounting for the reduction in both total time and time per contact.

4. Instructor-initiated Contacts. Few interactions were initiated by the instructor (1.6 per hour). They lasted an average of .6 minute per contact.

5. LCI Contacts. The AFUN supervisors spent 6 minutes per hour in contacts with their LCIs, almost 4 minutes less than was spent by BE/E supervisors. The difference is due to the duration of contacts (1.1 minutes) rather than to their frequency.

6. Administrative Activities. Almost 20 minutes per hour were spent on administrative activities, which is about the same as in the BE/E course. The small sample does not permit a stable estimation of variations over time of day, but the supervisor observed during the first period of the day spent more than twice as much time on these activities than did any other supervisor.

7. Nonproductive Activities. The supervisors spent 17.3 minutes per hour on nonproductive activities. This time might well have been reduced had the centers been operating at full capacity.

Testing Supervisor

BE/E

BE/E students took two relatively short phase tests (45 and 50 items) in a special testing center that contained 22 carrels. The answer sheets were submitted to a terminal in an adjacent room. One instructor manned the center for each shift. At the time of these observations, the school had about 340 students per shift.

Although the BE/E testing center was open for 5.5 hours each shift, students were not allowed to start tests during the last hour. This was to ensure that all would have time to finish the tests. For observation, each shift was divided into two periods, one of 2.5 hours and the other of 3 hours. If all students had completed their tests prior to the end of the last period, observations were terminated. The four periods were observed on different days of the week.

The role of the testing supervisor was quite specialized, requiring the development of three new categories of behavior (1-3 in Table 6). Less than 20 minutes per hour were spent in interactions with individual students. Students spent almost 7 minutes per hour waiting to see the instructor.

Table 6

BE/E Testing Supervisors:
Distribution of Activities

Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contact
1. Starting tests	5.1	5.9	0.9
2. Ending tests	5.9	5.7	1.0
3. Checking out	4.2	5.9	0.7
4. Manual evaluation of tests	2.2	1.0	2.1
5. Nontechnical questions	0.7	2.0	0.4
6. Instructor-initiated contacts	0.5	0.2	2.3
7. Administrative activities	2.1	--	--
8. Nonproductive activities	39.3	--	--
Total	60.0	20.7	

1-4. Testing Activities. The first four categories, constituting the normal testing cycle, can be discussed together. The instructor generally started a test by checking the test assignment, having the student read a set of instructions on testing procedures, assigning a carrel, and providing the student with the test, an answer sheet, and scratch paper. He ended a test by recording the time, checking the scratch paper and answer sheet, filing the test, and having the student read a set of instructions on how to submit his answer sheet to the scanner. He checked the student out by filing the answer sheet and explaining procedures for remedial assignments. When the terminal was not working, a manual evaluation of the test replaced the activities in the second and third categories. The testing supervisor processed six or seven students per hour. The entire process required roughly 2.5 to 3 minutes per student. There was a concentration of starts in the early part in the shift, a fairly stable period of starts and completions in the middle, and a gradual dwindling of completions toward the end.

5-7. Nontechnical Questions, Instructor-initiated Contacts, and Administrative Activities. Relatively little time was spent on these activities.

8. Nonproductive Activities. Almost 40 minutes per hour were spent on what was classified as nonproductive activities. However, at least part of this time was probably spent in essential monitoring activities. Two of the primary responsibilities of the instructor were maintaining test security and preventing cheating. Unfortunately, there was no way to make reliable distinctions between the time spent in this kind of surveillance and the time spent simply looking over the group while waiting for something else to do.

AFUN

Most AFUN students took either three or four (depending on rating) short (12 to 21 items) phase tests in a special testing center. The center had its own terminal, which was operated by the instructor. The center was open from 0730 to 1530.

During the period of observation, the center was manned by from one to three instructors. Since the level of activity was low, the activities of all instructors in the center at a given time were recorded and are reported (in Table 7) as if they were the activities of a single instructor. Nonproductive time is the difference between total productive time (for all instructors) and the length of the period observed. The day was divided into 2-hour periods, and each period was observed on a different day of the week.

Table 7

AFUN Testing Supervisors:
Distribution of Activities

Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contact
1. Starting tests	6.8	27.1	0.3
2. Ending tests	17.4	27.3	0.6
3. Nontechnical questions	2.3	5.0	0.5
4. Administrative activities	2.0	--	--
5. Nonproductive activities	31.5	--	--
Total	60.0	59.4	

Testing-supervisor activities are summarized in Table 7. They processed about 27 students per hour--roughly four times as many as in BE/E.

1. Starting Tests. The activities involved in starting a test were similar to those in BE/E but took less time. Part of this difference was probably due to the the higher percentage of students who had already taken at least one test (and therefore required little guidance), but a larger part was probably due to the use of more efficient procedures.

2. Ending Tests. These activities paralleled those in the ending test and checking out categories of the BE/E testing supervisors and the test evaluation category of the AFUN terminal operators. The average time required for the entire sequence was only .6

minute, however, which is the same as the average time required for the test evaluation activities and considerably less than the average time required for the combined ending test and checking out activities (1.7 minutes).

3-4. Nontechnical Questions and Administrative Activities. Relatively little time was spent on these activities.

5. Nonproductive Activities. The AFUN testing supervisor spent over half his time on what were classified as nonproductive activities (this would have been about 45 minutes per hour if separate observations had been reported). One instructor could handle the task of supervising the AFUN test center, even at full capacity, if he had help during the first 2 hours of the day and a relief during the lunch hour.

Shop Supervisor

BE/E

BE/E students took six performance tests in the performance testing center, or shop, which contained 38 testing stations and an instructor's desk. The center was manned by two instructors, who rotated frequently between sitting at the desk and circulating among the students. There were approximately 340 students per shift.

The performance testing center was open for 5.5 hours each shift. For purposes of observation, each shift was divided into two periods, and a different instructor was observed during each period. The periods were distributed over different days of the week.

Activities of the shop supervisors are summarized in Table 8. Only about half the instructor's time was spent on interactions with individual students, but the frequency of interactions (more than 1 per minute) was much higher than for any of the instructors discussed previously.

Table 8

BE/E Shop Supervisors:
Distribution of Activities

Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contact
1. Starting tests	3.7	9.2	0.4
2. School requirements	21.6	42.1	0.5
3. Technical questions	3.6	6.9	0.5
4. Nontechnical questions	1.0	1.8	0.6
5. Instructor-initiated contacts	0.6	1.2	0.5
6. Administrative activities	6.3	--	--
7. Nonproductive activities	23.1	--	--
Total	59.9	61.2	

1. Starting Tests. The activities involved in starting a new student were similar to those in other testing centers. The procedures were handled rapidly (about .4 minute each), just as they were in the AFUN testing center. The 9 starts per hour, substantially less than the 13 starts normal for the population in the school at that time, may have resulted from fluctuations expected with small samples.

2. School Requirements. Most tests required several checks on the student's work. The instructor could pass the student, fail him, or tell him to go back and repeat a portion of his work. Over 40 of these checks occurred each hour, accounting for over a third of the instructor's time.

3. Technical Questions. The instructors spent 3.6 minutes per hour on technical questions about the subject matter. Since the students were being tested, these contacts were relatively brief (.5 minute each).

4-5. Nontechnical Questions and Instructor-initiated Contacts. Little time was spent on these activities.

6. Administrative Activities. Approximately 6 minutes per hour were spent on administrative activities. Most of this time was devoted to preparing the testing stations for new students or repairing equipment.

7. Nonproductive Activities. Over a third of the instructor's time (23.1 minutes per hour) was spent on what was classified as nonproductive activity. However, as with other testing supervisors, part of this time was devoted to essential monitoring activities.

AFUN

The AFUN and BE/E shops differ in that the latter is a testing center whereas the former is primarily a training center. About half (depending on rating) of the AFUN students take two 1.5-hour shop projects, and the others, only one. The AFUN center has work stations for 56 students, plus a instructor's desk. During observations, five instructors were present, one at a desk and the others circulating through the shop. As in BE/E, jobs were frequently exchanged.

The AFUN shop was open from 0730 to 1530. This 8-hour span was divided into four 2-hour periods. A different instructor was observed during each of the four periods. Over three-fourths of the shop supervisor's time was spent in interactions with individual students, more time than was spent by any other instructors. The frequency of contacts was about the same as for the BE/E shop supervisors. Activities are summarized in Table 9.

1. Starting Projects. The instructors spent 4.4 minutes per hour starting new students on their projects. Each start took longer than it did in BE/E, but frequently several students were started at the same time. The figure for contacts per hour reflects the number of times the instructor engaged in this activity, not the total number of students he started.

2. School Requirements. About a quarter of the instructor's time was devoted to school requirements, principally checking on the students' work.

3. Technical Questions. A quarter of the instructor's time was spent on technical questions, considerably more than was spent by the BE/E shop supervisors. AFUN projects, however, were instructional exercises, not tests. The time per question (.8 minute) was less than half the time spent on technical questions by the AFUN LCIs.

Table 9

AFUN Shop Supervisors:
Distribution of Activities

Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contact
1. Starting tests	4.4	3.8	1.1
2. School requirements	15.3	26.3	0.6
3. Technical questions	16.6	20.0	0.8
4. Nontechnical questions	1.8	4.6	0.4
5. Instructor-initiated contacts	8.1	9.9	0.8
6. Administrative activities	1.8	--	--
7. Nonproductive activities	12.0	--	--
Total	60.0	64.6	

4. Nontechnical Questions. Less than 2 minutes per hour were spent on questions about procedures.

5. Instructor-initiated Contacts. Over 8 minutes per hour were spent on instructor-initiated contacts. Most of these occurred when one of the instructors circulating about the shop observed a student doing something wrong and corrected him on the spot. These contacts required only .8 minute each.

6. Administrative Activities. The instructors spent less than 2 minutes per hour on administrative activities. Because maintenance of tools and equipment would probably require more time than this, the figure may have resulted from fluctuations expected with small samples.

7. Nonproductive Activities. The instructor spent 12 minutes per hour in nonproductive activities.

Quiet-study Supervisor

BE/E

A special learning center for working during off-shifts was open for 4 hours each morning and afternoon. Both shifts were manned by the same three instructors. The center contained its own classroom terminal, which was also used by students from the testing center.

Most of the students in the center had been sent by their regular instructors because they were falling behind schedule. These students were required to work in quiet study for at least 2 hours a day. Other students used the center on a voluntary basis. The center had an average population of about 60 students.

Instructors in the quiet-study center followed different procedures from those followed in regular centers. Since there was a large turnover in the student population from day to day, no effort was made to maintain a one-to-one relation between instructors and individual students. One instructor sat at a desk near the terminal and specialized in activities related to terminal operations and testing. The other two instructors had desks out in the center but often circulated throughout the center. The instructor at the terminal was observed for a total of 6 hours distributed over the two shifts. The remaining instructors were observed for a total of 2 hours each, with the observations again distributed over the two shifts.

Table 10 summarizes instructor activities at the terminal. This instructor spent almost as much time on interactions with individual students (41.1 minutes per hour) as did the AFUN shop supervisor and had many more contacts per hour (74.3) than did any of the other instructors observed. He also had students standing in line for a greater amount of time (42.8 minutes per hour).

Table 10

BE/E Quiet-study Supervisors (Terminal):
Distribution of Activities

Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contact
1. Computer-initiated contacts	7.0	10.0	0.7
2. School requirements	19.5	34.9	0.6
3. Manual evaluation of tests	2.6	2.3	1.2
4. Technical questions	4.8	4.2	1.1
5. Nontechnical questions	2.6	8.5	0.3
6. Outside students	4.6	14.4	0.3
7. Administrative activities	4.9	--	--
8. Nonproductive activities	13.9	--	--
Total	59.9	74.3	

1. Computer-initiated Contacts. The instructor spent 7 minutes per hour on computer-initiated contacts. This was not much more time than was spent in the regular learning centers, but the frequency (10 per hour) was twice as great.

2. School Requirements. Almost a third of the time was spent on school requirements (.6 minute each); most consisted of requests for tests, checks on student work, or the collection of test cards after the student had completed a test. (In many regular learning centers, students checked test cards out and in without formal contact with the instructor.)

3. Manual Evaluation of Tests. The instructor spent 2.6 minutes per hour on the manual evaluation of tests. In this case, such evaluations were used to avoid the second failure of a remedial assignment (and the academic review board it would entail). The prevalence of such contacts resulted from the high concentration of students who were having problems.

4. Technical Questions. Only 4.8 minutes per hour were spent answering technical questions, considerably less than was spent in the regular learning centers. Most questions of this kind were handled by the regular quiet-study instructors.

5. Nontechnical Questions. These contacts accounted for only 2.6 minutes of the instructor's time but for a moderately large number of contacts.

6. Outside Students. This classification was used to account for all activities associated with students from the testing center. A student would either give his answer sheet to the instructor to be placed in the scanner or would ask permission to submit it to the scanner himself. This initial contact was frequently followed by a second contact during which the instructor changed the code on the answer sheet and resubmitted it for remedial assignments. These contacts accounted for relatively little time (4.6 minutes), but a relatively high percentage of the total contacts (almost 20%).

7. Administrative Activities. Administrative activities accounted for less than 5 minutes per hour.

8. Nonproductive Activities. The instructor spent 13.9 minutes per hour, or almost a quarter of his time, on nonproductive activities. Even with this amount of free time, students still had to spend a large amount of time waiting to see the instructor.

Table 11 summarizes the activities of the regular quiet-study supervisors. They spent as much time in interactions with individual students as did the instructor at the terminal, but the frequency of contacts was far less. Students spent more time waiting in line to see the instructor (51.5 minutes per hour) than they did in actual interactions with the instructor.

Table 11

BE/E Quiet-study Supervisors (Regular):
Distribution of Activities

	Type of Activity	Minutes Per Hour	Contacts Per Hour	Minutes Per Contract
1.	Computer-initiated contacts	1.0	1.7	0.6
2.	School requirements	24.5	13.7	1.8
3.	Technical questions	15.4	10.1	1.5
4.	Nontechnical questions	0.7	2.5	0.3
5.	Administrative activities	4.7	---	---
6.	Nonproductive activities	13.7	---	---
	Total	60.0	28.0	

1. Computer-initiated Contacts. Regular quiet-study supervisors spent much less time on computer-initiated contacts (1 minute per hour) than did the instructor at the terminal. This was due simply to the fact that the latter handled almost all such contacts as a specialized part of his job.

2. School Requirements. School requirements took 24.5 minutes per hour, with over 80 percent of the time devoted to the assignment and checking of practice problems. It is quite likely that this concentration on practice problems was prompted by the realization that most of the students were having difficulties with the course.

3. Technical Questions. The instructors spent over 25 percent of their time answering technical questions about the subject matter. A large part of this time was devoted to questions about practice problems.

4-5. Nontechnical Questions and Administrative Activities. Relatively little time was spent on these activities.

6. Nonproductive Activities. The time spent on nonproductive activities (13.7 minutes per hour) further substantiates the fact that students can spend a large amount of time waiting to see the instructor, even when the instructor has a considerable amount of free time.

AFUN

A quiet-study center for AFUN students was available four nights a week from 1600 to 1800, but it was used neither as systematically nor as extensively as the BE/E center. This was due, in part, to the length of the course. School administrators felt that valid measures of a student's performance could not be developed until he had completed most of the course, so variations in training time were not used as automatic triggers for quiet-study assignments as they were in BE/E.

The AFUN quiet-study center was observed informally on several occasions. It was decided that the level of activity (students could not, for example, submit tests) did not merit more systematic observation.

Summary

Table 12 summarizes instructor activities in various roles. The use of broad categories simplifies comparisons but, in some cases, it masks major variations in specific activities within the categories. For example, the table shows that shop supervisors in AFUN and BE/E spent roughly the same amount of time in individual student-instructor contacts. However, as noted previously, there were large differences in the time devoted to technical questions and instructor-initiated contacts.

Table 12

Summary of Activities in Different Jobs

Role	Individual Student-Instructor Contacts		Productive Time Not in Individual Contacts	Nonproductive Time
	No./Hr.	Min./Hr.	Min./Hr.	Min./Hr.
Learning center instructor:				
BE/E	34.0	41.7	8.0	10.4
AFUN	17.6	27.0	9.9	23.2
Classroom terminal operator--AFUN	56.2	32.7	5.7	21.6
Learning center supervisor:				
BE/E	8.6	17.9	29.3	12.8
AFUN	10.6	17.0	25.8	17.3
Testing supervisor:				
BE/E	20.7	18.6	2.1	39.3
AFUN	59.4	26.5	2.0	31.5
Shop supervisor:				
BE/E	61.2	30.5	6.3	23.1
AFUN	64.6	46.2	1.8	12.0
Quiet-study supervisor--BE/E:				
Terminal	74.3	41.1	4.9	13.9
Regular	28.0	41.6	4.7	13.7

DISCUSSION

Division of Duties

At a general level, the jobs in the BE/E and AFUN courses are similar to one another and probably to jobs in many military courses. At a detailed level, however, they are far from standardized. For example, the addition of a terminal operator to the AFUN learning center led to substantial modifications in the duties of the regular LCIs. Instructor responsibilities in the BE/E quiet-study center were quite different from those in the regular learning center. In fact, duties of the BE/E LCIs have varied considerably at different times and in different locations. Laboratory exercises, performance tests, module tests, and phase tests have sometimes been handled by LCIs and sometimes by special instructors. Even when the jobs are relatively free from the complications of divided responsibilities, as with shop supervisors, the instructors' activities may vary considerably as the result of other factors. For example, the shop projects in AFUN were more like the laboratory exercises in BE/E (handled by the LCI) than like the performance tests in BE/E (handled by the shop supervisors). As a result, the AFUN shop supervisor was more an instructor than a test monitor, and the BE/E shop supervisor was more a test monitor than an instructor.

Inequities in demand occurred in both courses. In BE/E, testing supervisors and the shop supervisors were not as busy as LCIs. In both cases, however, considerations other than the most effective use of instructors prevailed--test security in the test center and optimum use of facilities and equipment in the shop. Both centers were manned at such low levels that further reductions would not have been practicable. In AFUN, the LCIs were not as busy as the shop supervisors but were busier than the testing supervisors. In this course, manning levels could probably be adjusted to equalize demand.

At the time of these observations, neither course was using helpers or assistants who specialized in nontechnical jobs. The Air Force has considered using such aids to release more qualified technicians for operational assignments. In the Navy, however, where there is a shortage of shore billets for technically qualified personnel, alternative assignments for instructors might be even less productive than their present ones. Nevertheless, assistants might prove to be practicable. Recent BE/E graduates have been used as specialists to issue and receive tests and laboratory equipment and even as regular LCIs. An examination of student-instructor interactions in both courses suggests that many could be handled by relatively bright aids of this kind after some supervised practice.

Tutorial Interactions

Most of the instructor's activities were devoted to brief procedural interactions. There were few complex dialogues of the kind considered in many discussions of the instructor's role, and little indication that instructors devoted a major share of their time to those students who were having unusual difficulties.

Half the interactions in BE/E required nothing more tutorial than checking an answer sheet or telling the student where to find a particular piece of equipment. Interactions in the more tutorial-sounding categories took more time than did the clearly procedural interactions, but the differences were not large. Asking and answering a technical question required less than 1.66 minutes. Oral remediation added only 1.4 minutes to comparable interactions without oral remediation, and most of this time was spent in locating the tests and items. For the remediation itself, the instructor would frequently read the question, ask the student if he knew the answer, and, if he didn't, tell him. This is a kind of tutorial activity, but it is quite different from that generally associated with the term. Even nondisciplinary instructor-initiated interactions, most of which were devoted to counseling, lasted less than 2 minutes.

In AFUN, there were fewer interactions of the purely procedural kind, and oral remediations were longer. However, all observers agreed that complex tutorial interactions were as rare in AFUN as in BE/E.

The low levels of complex tutorial interactions observed in these courses may indicate suboptimal use. On the other hand, the more routine features of the system may be handling student difficulties so well that there is no need for the more time-consuming interactions. A choice between these two possibilities is impossible without a direct experimental evaluation.

Complex tutorial interactions are expensive. In a course like BE/E, where demands on the instructor are high, even a slight increase in their frequency could lead to a substantial increase in the time students spend waiting to see the instructor. This waiting time is a direct cost. There are also indirect costs. One of the primary reasons for scheduling many contacts between students and instructors is to provide opportunities for

any complex interactions the instructor may feel are needed. If these opportunities are rarely used, demands on both the students and instructors could be reduced by replacing some student-instructor contacts with algorithms built into the computer program or into the instructional materials themselves.

Student-to-instructor Ratios

If the learning centers had been operating at capacity, the student-to-instructor ratios for the two courses would have been fairly similar, although the BE/E instructors would have been much busier than their AFUN counterparts. The average BE/E LCI had students waiting for 27 minutes per hour. This is 135 minutes of nonproductive student time per hour for each learning center, and is probably enough to warrant an additional instructor. In AFUN, on the other hand, the average LCI had a sizeable excess of free time. If the number of regular LCIs per center were reduced from five to four, those remaining would still have 14 minutes per hour of nonproductive time, plus a cushion of over 13 minutes per hour for monitoring and spontaneous instructor-initiated contacts. These adjustments would leave the overall student-to-instructor ratio in the AFUN learning centers half again as large as that in the BE/E.

This research indicates that demands on the instructor differ from course to course and that the same student-to-instructor ratio is not always appropriate for parallel positions in different courses. A variety of factors affects the demands on instructors; some of the major factors affecting three categories of LCI activity--namely, computer-initiated contacts, school requirements, and technical questions--will be considered as examples and are discussed in the following paragraphs.

Computer-initiated Contacts

Computer-initiated contacts serve a variety of purposes. The most obvious is to handle students who have exhausted their regular instructional resources without reaching an acceptable level of mastery. The frequency of computer-initiated contacts will vary with the difficulty of tests, and this, in turn, will vary with the complexity of the subject matter and the amount of training provided. It would be possible to prepare materials that would reduce errors to a very low level over a wide range of subject matters, but this would not be an efficient instructional strategy in a system that relies heavily on remedial assignments to adjust the instruction to individual differences. The frequency of computer-initiated contacts will also vary with standards of acceptable performance. In BE/E, the standard was 100 percent; in AFUN, it was 90 percent. Since many scores will fall within this range, the difference should have a substantial impact on the number of remedial assignments required to reach the standard. Finally, the frequency will vary with the number of remedial assignments actually available for use at any given point in the course.

Computer-initiated contacts provide an opportunity for oral remediation, which is used when the instructor can provide remediation that is more effective or less expensive than other form of remediation. It is frequently used when other forms of remediation have already been tried without success. It is also used when relatively little remediation is required--for example, when a BE/E student scored between 90 and 99 percent on a module test. Oral remediations accounted for only a third of the computer-initiated contacts in BE/E, but for essentially all of them in AFUN.

Computer-initiated contacts also notify the instructor that the student is having difficulties and provide opportunities for counseling, initiating academic review boards, or selecting from among alternative forms of remediation. In BE/E, for example, the

student was sent to the instructor when he scored below 70 percent on a module test or below 100 on a lesson test, even when the computer had already made a remedial assignment.

All of these factors contribute to the fact that there were almost twice as many computer-initiated contacts in BE/E as in AFUN. However, almost half again as much time was spent on them in AFUN as in BE/E. Part of the difference in time was probably due to the greater number of errors covered by each oral remediation in AFUN (which would increase time) and the many opportunities for counseling that were provided but rarely used in BE/E (which would decrease time). Part was probably due to a tendency for instructors to adjust the duration of interactions to demands on their time. BE/E instructors, who frequently had students waiting, tended to shorten the time spent on each interaction. AFUN instructors, on the other hand, with considerable free time, tended to extend their interactions to fill the available time.

School Requirements

School requirements accounted for the largest difference in LCI activities in the different courses. In BE/E, they accounted for almost half the interactions; in AFUN, they accounted for none of the interactions.

The scoring of laboratory exercises accounted for about 15 percent of these contacts. Alternative forms of scoring were precluded by variations in laboratory equipment.

Practice problems accounted for another 20 percent of these contacts (and almost a third of the time). Practice problems were developed and scored by individual instructors in an effort to compensate for deficiencies in the instructional materials. There were wide variations in their use. Such problems should be provided as part of the regular instructional materials, and most, like other problems in the workbooks, could be scored by the students themselves.

The remaining contacts in this category were checks to ensure that the student was following proper procedures and working his way through the materials in the intended manner. The instructors checked workbooks for completion, granted permission to take tests and laboratory exercises, checked tests in and out, recorded student progress, and checked answer sheets for proper format. The instructors differed widely in the extent to which they enforced these requirements.

In summary, it appears that the observed differences in school requirements are due less to differences in course content than to differences in opinion. In AFUN, it was assumed that the system itself would take care of procedural matters with minimum intervention by the instructor. This assumption was shared by at least some of the instructors in BE/E. If it had not been, differences between the courses would have been much larger.

Technical Questions

The most obvious reason for technical questions is difficult subject matter or, more precisely, instructional materials that are inadequate for instructional requirements. Frequency of questions will also vary with the availability of the instructor. A student who would question an instructor walking by his carrel might be reluctant to stand in line behind seven or eight other students. Finally, it appears that at least some questions are motivated less by a need for information than by a need to establish contact with the instructor or simply to relieve boredom. Since the frequency of technical questions was greater in BE/E than in AFUN, even though the instructors were busier and there were

more student-instructor contacts for other reasons, the difficulty of the subject matter must have played a dominant role.

The time spent on each technical question should vary directly with the complexity of the subject matter. The subject matter in BE/E is much more complex than that in AFUN, but the time spent on each question was less. The most likely explanation is a compensatory adjustment for available time, the same factor that was suggested to explain differences in the length of computer-initiated interactions.

Conclusions

The discussion of activities in these three categories indicates how demands on the instructor and, ultimately, the student-to-instructor ratios are driven by a variety of interacting influences. Course content is important but, in most cases, its effect is moderated by the way in which the course has been designed (both written and implemented). In fact, the choice of course designs seems to have played a dominant role in determining most of the demands encountered in this study.

In designing a course, there are many opportunities for tradeoffs between demands on the instructor and the effectiveness of instruction. The wide variations between these courses, and even between instructors in the same course, indicate that these tradeoffs are not being made consistantly. Some of these choices are presumably better than others, but it would be difficult to guess which are which. There is an obvious need for objective guidelines, but the research required for their development would be quite extensive.

In the absence of such guidelines, there is no real alternative to accepting existing demands as the basis for student-to-instructor ratios. Initial manning levels could be based on similar courses and subsequently refined through observations of nonproductive time and waiting time.

Instructor Training

Part of instructor training is in centralized courses that permit the efficient use of instruction resources and provide centralized control over the material taught. However, the wide variety of activities observed in this study suggest that it would be difficult to design a curriculum that is truly common to all the jobs it must serve.

Most instructor training courses contain some general material on the principles of individualized instruction and the instructor's role in such systems. This material is apparently used more for its effect on attitude and motivation than to develop any particular job skill. There is a tendency to stress the fact that the instructor will be freed from teaching dry facts and the computer will assume the routine of grading tests and handling paperwork. Emphasis is placed on the more sophisticated skills required for the diagnosis and correction of unusual student difficulties. In some cases, this material may create expectations that are subsequently disconfirmed on the job; when this occurs, the effect on motivation may be opposite to that intended. In BE/E, for example, the LCIs spent the major part of their time on relatively routine activities, and many expressed resentment that such activities left little time for complex tutorial interactions. For these instructors, it might be better to emphasize the importance of the less attractive job requirements rather than the more glamorous activities.

Finally, the lack of reliable information about how to use instructors most effectively, mentioned earlier, has obvious implications for instructor training. There will

be little improvement in this area until more is known about how instructor training affects instructor behavior and how instructor behavior affects student learning.

CONCLUSIONS

BE/E and AFUN differed in terms of which functions were assigned to instructors and which were assigned to elements of the instructional system. They also differed in the division of functions among various specialized jobs. There were wide variations in the demands experienced by instructors in different jobs within a single course and in those experienced by instructors in similar jobs in different courses.

Part of the variability in demand stemmed from differences in course content, but most of it stemmed from differences in course design. There were differences in the sizes of modules, the standards of mastery, and the criteria for instructor intervention, all of which affected demand. Certain procedures imposed in one course were completely absent in the other. Each course selected some design alternatives that created low demand and others that created high demand; thus, the possible variation in total demand could be far greater than that which was actually observed.

Uniformity of course design does not ensure that the design is right, but major differences of the kind found in this study do suggest areas in which the design of one or the other of the two courses is less than optimal. There is little empirical data of the kind needed to resolve these disagreements.

A completely standardized set of student-to-instructor ratios would not accommodate real differences in demand such as were found in this study. Some courses would receive more instructors than they really need and others would not receive enough. Until more is known about optimal course design, the options should not be constrained by imposing arbitrary student-to-instructor ratios.

RECOMMENDATIONS

1. A single set of student-instructor ratios should not be used to compute instructor authorizations for all courses taught by individualized computer-managed instruction.

2. Instructor training courses should avoid creating unrealistic expectations about what instructors in individualized courses will actually do on the job. Since instructor roles vary so widely, considerable caution should be exercised in selecting a common core curriculum for such courses.

APPENDIX A

BE/E AND AFUN COURSE CURRICULA

BE/E COURSE CURRICULUM

Lessons on Electronics

Module One--Electrical Current

- I Electricity and the Electron
- II Electron Movement
- III Current Flow
- IV Measurement of Current
- V The Ammeter

Module Two--Voltage

- I EMF from Chemical Action
- II Magnetism
- III Electromagnetic Induction
- IV AC Voltage
- V The Use of AC and DC
- VI Measuring Voltage

Module Three--Resistance

- I Characteristics of Resistance
- II Resistors
- III Resistor Valves
- V Ohmmeters

Module Four--Measuring Current and Voltage in Series Circuits

- I Measuring Current in a Series Circuit
- II Voltage in a Series Circuit
- III Using the Multimeter as a Voltmeter

Module Five--Relationships of Current, Voltage, and Resistance

- I Voltage, Resistance, and Current
- II The Ohm's Law Formula
- III Power
- IV Internal Resistance
- V Troubleshooting Series Circuits

Module Six--Parallel Circuits

- I Rules for Voltage and Current
- II Rules for Resistance and Power
- III Variational Analysis
- IV Troubleshooting Parallel Circuits

Module Seven--Combination Circuits and Voltage Dividers

- I Solving Complex Circuits
- II Voltage Reference
- III Voltage Dividers

Module Eight--Induction

- I Electromagnetism
- II Inductors and Flux Density
- III Inducing Voltage
- IV Inductance and Induction

Module Nine--Relationships of Current, Counter EMF, and Voltage in LR Circuits

I Rise and Decay of Current and Voltage
II LR Time Constant
III Using Universal TC Chart
IV Inductive Reactance
V Relationships in Inductive Circuits
VI Phase Relationships

Module Ten--Transformers

I Transformer Construction
II Transformer Theory and Operation
III Turns and Voltage Ratios
IV Power and Current
V Transformer Efficiency
VI Semiconductor Rectifiers

Module Eleven--Capacitance

I The Capacitor
II Theory of Capacitance
III Total Capacitance
IV RC Time Constant
V Capacitive Reactance
VI Phase and Power Relationships
VII Capacitor Design Considerations

Module Twelve--Series AC Resistive-Reactive Circuits

I Voltage and Impedance in AC Series Circuits
II Vector Computations
III Rectangular and Polar Notation
IV Variational Analysis of Series RL Circuits
V Frequency Discrimination in RL Circuits
VI Series RC Circuits

Module Thirteen--Series AC RLC Circuits

I Solving RLC Circuits
II Resonant Frequency in Series Circuits
III Conditions of Series Resonance
IV Experiments with Series Resonance

Module Fourteen--Parallel AC Resistive-Reactive Circuits

I Solving for Quantities in RL Parallel Circuits
II Variational Analysis of RL Parallel Circuits
III Parallel RL and RCL AC Circuits
IV Parallel Resonance
V Effective Resistance in Parallel RL Circuits
VI Parallel Resonance Experiments

Lessons on Mathematics

Module One

I Introduction to Arithmetic
II Decimals
III Signed Numbers
IV Powers of Ten
V Conversion of Electrical Units

Module Five--Solving Formulas

Module Six--Fractions

Module Nine--Percentages

Module Ten--Ratio and Proportion

Module Twelve

I Mathematics of Angles
II Square and Square Roots

AFUN COURSE CURRICULUM

Module One

- I Basic Theory of Flight and Aircraft Nomenclature
- II Military Aircraft Designation System

Module Two

- IN Naval Aviation Rating Familiarization (Navy only)
- IIN Naval Aviation Organization (Navy only)
- IM Marine Aviation Organization (Marine only)

Module Three

- I Aircraft Handling
- II Standard Aircraft Taxi Signals
- III Aviation Support Equipment

Module Four

- I Basic Aircraft Systems
- II Aviation Fuels, Oils, and Hydraulic Fluid
- III Aircraft Cleaning

Module Five

- I Aircraft Carriers
- II Aircraft Firefighting

Module Six

- I Naval Aircraft Maintenance Program
- II Planned Maintenance System
- III Maintenance Data Reporting

Module Seven

- I Maintenance Data Collection System
- II Work Unit Code Manual
- III Support Form

Module Eight

- I Maintenance Requirement Cards
- II Man-Hour Accounting
- III Unsatisfactory Material Condition Report

Module Nine

- I Visual Information Display System/Maintenance Action Form

Module Ten

- I Screwdrivers and Pliers
- II Wrenches

Module Eleven

I Torque Wrenches
II Aircraft Hardware

Module Twelve

I Lockwiring
II Mechanics of Heat and Gases, Basic Hydraulics, and Static Electricity
III Corrosion

Module Thirteen

I Maintenance and Operations Manuals
II Maintenance Information Automated Retrieval System

Module Fourteen

I Math Whole Numbers

Module Fifteen

I Math Fractions

Module Sixteen

I Math Decimals

Module Seventeen

I Striking Tools, Punches, and Chisels
II Measuring and Marking Tools and Drills
III Files, Hacksaws, and Vices

APPENDIX B

VARIATIONS IN LCI ACTIVITIES

Table B-1

BE/E LCIs: Variations in Times Over Shifts
(Times in Minutes Per Hour)

Type of Activity	Shift	
	Morning	Afternoon
Computer-initiated contacts	5.5	6.9
School requirements	15.4	15.9
Manual evaluation of tests	1.9	2.3
Technical questions	13.0	13.5
Nontechnical questions	3.1	2.8
Instructor-initiated contacts	1.7	1.2
Administrative activities	7.1	8.8
Nonproductive activities	12.3	8.5
Time Students Spend Waiting in Line	22.6	32.5

Table B-2

BE/E LCIs: Variations in Times Over Days
(Times in Minutes Per Hour)

Type of Activity	Days				
	Mon	Tue	Wed	Thu	Fri
Computer-initiated contacts	6.0	5.6	6.0	4.7	8.9
School requirements	14.0	18.4	17.0	10.0	18.8
Manual evaluation of tests	2.8	1.6	2.6	1.9	1.6
Technical questions	13.5	11.8	10.1	19.3	11.7
Nontechnical questions	2.8	2.4	4.1	2.4	3.1
Instructor-initiated contacts	1.1	0.9	0.9	3.3	1.0
Administrative activities	11.2	7.5	6.1	8.7	6.5
Nonproductive activities	8.7	11.7	13.3	9.8	8.5
Time Students Spend Waiting in Line	37.8	28.8	21.0	16.2	33.9

Table B-3

BE/E LCIs: Variations in Times Over Hours
(Times in Minutes Per Hour)

Type of Activity	Hours					
	1	2	3	4	5	6
Computer-initiated contacts	4.4	5.4	7.7	8.1	7.5	4.3
School requirements	13.3	17.6	19.9	16.6	15.9	10.5
Manual evaluation of tests	1.7	2.0	1.3	2.4	1.9	3.3
Technical questions	9.8	12.0	15.1	15.5	12.9	14.3
Nontechnical questions	3.5	2.7	2.2	2.3	2.9	4.2
Instructor-initiated contacts	1.7	0.8	1.3	1.8	.9	2.2
Administrative activities	17.4	7.9	4.4	5.8	5.5	7.4
Nonproductive activities	8.2	11.6	8.1	7.5	13.0	13.8
Time Students Spend Waiting in Line	15.6	18.2	30.1	35.9	34.2	31.2

Table B-4

AFUN LCIs: Variations in Times Over Days
(Times in Minutes Per Hour)

Type of Activity	Days				
	Mon	Tue	Wed	Thu	Fri
Computer-initiated contacts	14.8	8.1	13.1	6.6	3.7
Technical questions	6.5	8.3	5.4	11.5	14.4
Nontechnical questions	5.9	2.9	6.4	2.7	5.9
Instructor-initiated contacts	1.5	7.6	1.3	2.3	3.9
Administrative activities	11.4	10.5	7.9	12.1	7.8
Nonproductive activities	20.0	22.5	25.8	24.7	22.7

Table B-5

AFUN LCIs: Variations in Times Over Hours
(Times in Minutes Per Hour)

Type of Activity	Hour						
	1	2	3	4	5	6	7[a]
Computer-initiated contacts	11.5	4.0	5.1	8.2	11.9	19.6	6.2
Technical questions	8.1	9.4	12.8	9.3	10.8	5.9	8.5
Nontechnical questions	5.8	2.8	3.0	6.9	5.0	3.7	5.9
Instructor-initiated contacts	4.6	1.0	5.2	4.5	4.7	2.0	3.6
Administrative activities	11.3	9.7	10.1	9.7	7.0	5.8	13.2
Nonproductive activities	18.1	33.2	22.8	22.1	20.0	23.4	22.7

[a]The values in this column were based on a 90 minute period, but were multiplied by .67 so that they would be comparable to the values in the remaining columns.